# Rare plant recovery in Mallee woodlands

David Cheal[1,2], Claire Moxham[1], Sally Kenny[1] and Jessica Millet-Riley[1]

[1] Arthur Rylah Institute for Environmental Research, Department of Environment and Primary Industries
123 Brown Street, Heidelberg, Victoria 3084
[2] corresponding author; School of Science, Information, Technology & Engineering,
University of Ballarat, PO Box 663, Ballarat, Victoria 3353

**Abstract**
Recent botanical surveys in semi-arid woodlands in the Victorian Mallee have provided further records of 28 plant species considered rare or threatened. The threat status of 10 species is recommended for review, as they appear to be more common than in their current listing. Botanical collections in 2012 include the first Victorian specimen record for the Desert New Holland Daisy *Vittadinia eremaea*. The records of these rare or threatened plants come after two decades of browsing and grazing control, which enabled the woodland flora to take advantage of the breaking of the drought in 2010. From 2010 to 2012 rainfall extended into the normally dry summers, providing two consecutive and unusually benign summers with good recruitment opportunities. Low grazing and browsing pressure is a necessary precursor for regeneration of many of these species and the semi-arid woodland they constitute. (*The Victorian Naturalist* **130** (3) 2013, 96-108)

**Keywords**: Woodland recovery, rare plants, semi-arid, grazing, regeneration

## Introduction

Semi-arid non-eucalypt woodlands (hereafter semi-arid woodlands) are an important component of the Victorian Mallee region. Semi-arid woodlands are characteristically dominated by trees other than eucalypts, notably Belah *Casuarina pauper*, Buloke *Allocasuarina luehmannii*, Slender Pine *Callitris gracilis* and Sugarwood *Myoporum platycarpum* (plant nomenclature follows Walsh and Stajsic 2007). Lower strata may be dominated by various grasses, forbs and cryptogams (notably lichens and mosses), or a variety of characteristic shrubs (e.g. *Acacia* spp., *Senna* spp.) (White *et al.* 2003). These woodlands once covered extensive tracts of the Mallee region, but today are restricted largely to the National Parks and Flora and Fauna Reserves (Connor 1966; Sluiter *et al.* 1997; White *et al.* 2003; Callister 2004).

### *Management history*

Semi-arid woodlands have been cleared extensively for agriculture, timber harvesting (especially Slender Pine) and grazing. They have been further impacted by high populations of browsing and grazing animals, notably rabbits and kangaroos (Cohn and Bradstock 2000; Morcom 2000; Sandell *et al.* 2002; Sandell 2006). In 1977 and again in 1987, the Land Conservation Council recognised the severe and extensive depletion of these woodlands and the severe degradation of the remaining woodlands, and recommended their further reservation into what are now the Mallee National Parks and Reserves (Land Conservation Council 1977; 1987).

The composition of the remaining woodlands is substantially dependent on the local (site-specific) management history. Most remnant stands have been changed greatly following a century or more of fires (to which these woodlands are particularly susceptible), timber harvesting (especially Slender Pine), browsing and grazing by domestic, native and feral mammals, weed invasion and other novel intrusions into ecological processes (Gowans and Westbrooke 2002; Callister 2004; Gowans *et al.* 2005; Cheal 2009a, b; Gowans *et al.* 2010) such as wind-blown sand (Cheal *et al.* 2012). This wind-blown sand (a result of overgrazing and clearing) has been a problem since European settlement and continues today. It has the ability to 'bury' large areas of semi-arid woodland and mallee shrublands. Areas in Hattah-Kulkyne and Wyperfeld National Parks have been replanted in the past in order to stabilise the shifting sands.

Soil disturbance has also been reduced through the removal of stock grazing, a key management focus in the parks soon after res-

ervation. Additional browsing species currently include rabbits, hares, kangaroos and goats, and their numbers fluctuate as a result of control measures and climatic conditions (i.e. numbers decrease in drought periods and increase in wet periods when abundant feed is available).

***Recovery and Restoration***

Previous studies within these Mallee Parks and Reserves found that grazing-sensitive ground layer plants can recover quite rapidly with reduced grazing pressure (Sandell 2002; Cheal 2009a; Gowans *et al.* 2010), but recovery of woody perennial species such as shrubs and trees is more variable. Gowans *et al.* (2010) found a ≥ 80% increase in mean species richness of the shrub layer in Pine-Buloke woodlands in Wyperfeld National Park, following stock removal and early control of browsers, notably rabbits, hares, goats and kangaroos.

Regeneration and/or recruitment events in the Mallee are sporadic (Batty and Parsons 1992; Sinclair 2005; Sandell 2006). Pre-conditions for both germination and establishment are largely unknown; however, it is thought that unusually heavy or prolonged rainfall is important to facilitate establishment and continued survival (Sinclair 2005; Sandell 2006). Successful regeneration of Belah has been observed where water accumulates in low-lying areas following heavy rainfall (Westbrooke 1998). Sugarwood regeneration also occurred following the establishment of the rabbit calicivirus in 1996 (Sandell 2002; Sandell *et al.* 2002; Cheal 2009b).

Semi-arid vegetation is necessarily slow-growing. Low mean annual rainfall reduces growth rates and variable and unpredictable rainfall patterns make plant establishment a rare and unreliable event for many plant species, including the dominant trees and shrubs. Consequently, ecological impacts have very long-lasting consequences. For example, many of the surviving Buloke trees most likely predate the arrival of rabbits in the 1860s (Castle 1989; Raymond 1990; Sluiter *et al.* 1997; Williams *et al.* 2004a, b). Recognisable (but degraded) Buloke Woodlands still exist, even though there has been scant regeneration for a century and a half. The corollary of this tolerance to adverse ecological management is that recovery is also slow and extended. Immediate reversal of a degrading process (such as high grazing pressure) does not produce rapid recovery of woodland that is original or in good condition. It may take many decades, and an accumulation of rare stochastic circumstances (such as cooler summers with extended rainfall) before degraded communities approach undisturbed condition states.

***Climate***

Droughts in north-western Victoria may be both seasonal and over much longer periods. Seasonal drought is a characteristic feature of the regional environment, with marked water deficits from December to April-May (White *et al.* 2003). A longer-term pattern of drought may be superimposed on this annual pattern, such as the recent rainfall deficit of the decade that finished in 2010-2011 (Fig. 1, Australian Bureau of Meteorology 2012). Seasonal drought is part of the regional landscape and rarely has long-term repercussions on the current flora and vegetation (White *et al.* 2003). Longer-term drought can have dramatic adverse impacts on the survival and regeneration of long-lived species. Decadal drought has been suggested as a reason for the recent widespread deaths of Slender Pines in the western Murray-Sunset National Park (Cheal *et al.* 2007). Of course, drought is largely unmanageable (i.e. there is scant management response that ameliorates drought) with the possible exception that, to a certain extent, herbivore control and the associated reduction in browsing and grazing pressure mimic a good season in its impacts on the local vegetation and flora (Cheal *et al.* 2007).

Recently, in 2010 to 2012, two unseasonably mild and damp summers have occurred (Fig. 1; Australian Bureau of Meteorology 2012). Moister summers are very rare (maybe once every 20 to 30 years), but may be essential for the regeneration of many of the local plant species. The above-average rainfall in 2011 provided a unique opportunity to determine differing rates of regeneration across the semi-arid woodlands of the Mallee.

In the past, heavy grazing by rabbits, hares, goats, stock and kangaroos prevented plants from taking advantage of these occasional climatic conditions favourable to regeneration. However, concerted

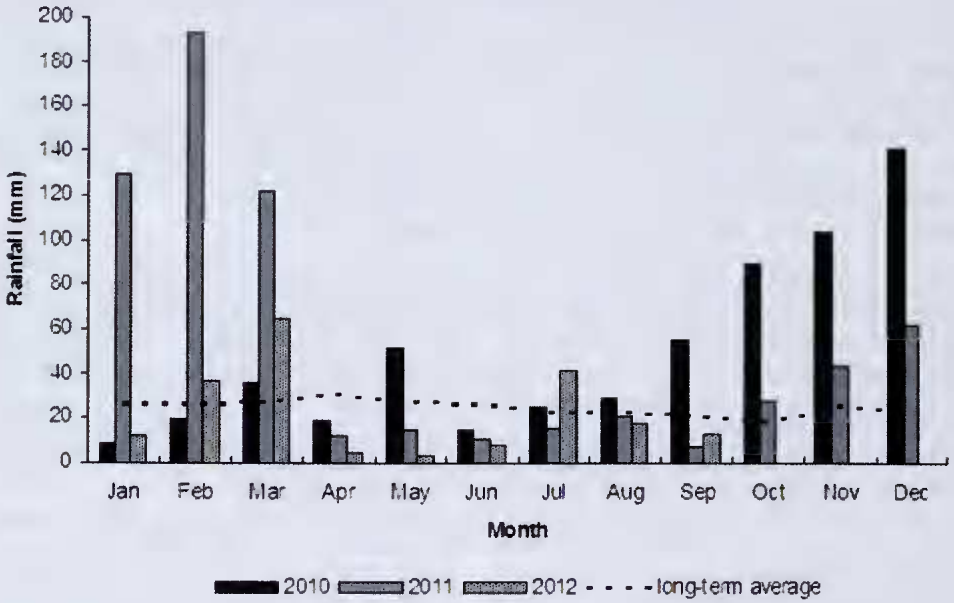


**Fig. 1.** Rainfall (mm) 2010 to 2012 and long-term average (Mildura station, Australian Bureau of Meteorology 2012).

efforts to control these mammalian grazers and browsers (Sandell *et al.* 2002; Sandell 2002; Cheal 2009a; Gowans *et al.* 2010) have culminated recently in an extended period of reduced impact, putatively providing the essential pre-conditions for regeneration of many species which had become rare after decades (more than a century) of adverse management.

## Methods

As part of a project assessing the quality of remnant semi-arid woodlands in north-western Victoria, field surveys were conducted in January and February 2012. Surveys were restricted to the Wyperfeld, Hattah-Kulkyne and Murray-Sunset National Parks and Yarrara Flora and Fauna Reserve (Figs. 2 and 3) and were restricted to sites that supported semi-arid woodland or that were believed to have formerly supported semi-arid woodland. Data collected during the survey were largely habitat structural aspects (e.g. tree density, cover of various vegetation strata), with very few floristic data, mostly tree and larger shrub species. The methods used during the survey, the number of sites visited and other background to the regional survey are available in Kenny *et al.* (2012). The species discussed below were incidental records, noted and collected when assessing sites for the target project. The project report is available from the Mallee CMA and Parks Victoria.

During these surveys 28 species listed on the Department of Environment and Primary Industries' (DEPI's) Advisory List of Rare and Threatened Species (DSE 2005) were found.

**Fig. 2.** The location of the major reserves in north-western Victoria, and the focus areas of semi-arid woodland sampling for the survey.

**Fig. 3.** Less disturbed semi-arid woodland, in Yarrara Flora and Fauna Reserve.

These species are individually and briefly discussed below.

**Results**

Most threatened species are found in low abundance and often their distributions and abundances have been impacted negatively by extensive clearing, browsing and grazing in the region. As a result, they are represented sparingly in survey data sets. The current survey returned more than 115 records of rare or threatened species—a surprisingly high number (Table 1), particularly as rare or threatened species were not targeted. Easting/northing was determined by GPS unit, datum GDA 94, zone 54.

***Abutilon otocarpum* Desert Lantern**

DEPI list: vulnerable.

New Records: Five new localities, two with 100+ plants; all within former range.

Representative Locality: 501668 / 6213467

Specimens: Lodged with the ARI Herbarium.

Implications: None; current status is supported. The plant is not widespread. It occurred in two localised populations of no more than 100 plants each, on otherwise unremarkable sites on low rolling dunes in former woodland. The plant is probably subject to heavy browsing in 'normal' seasons and reasonably considered threatened in Victoria. It is not considered threatened elsewhere in Australia. The seeds are capable of long-term storage in a soil seed bank. Previous germination experiments under 'fresh' and seed heated trials resulted in no germination (Ooi *et al.* 2009).

***Acacia colletioides* Wait-a-while**

DEPI list: rare.

New Records: Three new localities, with few plants at each; all within former range.

Representative Locality: 561450 / 6177402

Implications: None; current status is supported. In Victoria, Wait-a-while is restricted to the northern Mallee, where it is uncommon

**Table 1.** Rare or threatened species recorded in the semi-arid woodlands of north-western Victoria in 2012. 'Incidental' refers to those species recorded outside recent quadrat-based surveys. * indicates species which are also listed under the *Flora and Fauna Guarantee Act 1988*.

| Scientific name | English name | DEPI list Conservation status | Number of records |
|---|---|---|---|
| *Abutilon otocarpum* | Desert Lantern | Vulnerable[1] | 5 |
| *Acacia colletioides* | Wait-a-while | Rare[2] | 3 |
| *Amyema linophylla* | Buloke Mistletoe | vulnerable | Incidental |
| *Atriplex acutibractea* | Pointed Saltbush | rare * | Incidental |
| *Convolvulus clementii* | Desert Bindweed | vulnerable | Incidental |
| *Eremophila oppositifolia* | Twin-leaf Emu-bush | rare | 6 |
| *Eremophila scoparia* | Scotia Bush | rare | 1 |
| *Eriochlamys behrii*[3] | Woolly Mantle | rare | 1 |
| *Jasminum didymum* | Desert Jasmine | vulnerable | 4 |
| *Maireana georgei* | Slit-wing Bluebush | vulnerable | 2 |
| *Maireana sedifolia* | Pearl Bluebush | rare | 1 |
| *Maireana triptera* | Three-wing Bluebush | rare | 12 |
| *Marsdenia australis* | Doubah | vulnerable | 2 |
| *Phyllanthus lacunellus* | Sandhill Spurge | rare | 2 |
| *Ptilotus sessilifolius* | Crimson Tails | poorly known[4] | 1 |
| *Radyera farragei* | Bush Hibiscus | vulnerable | 2 |
| *Rhagodia ulicina* | Spiny Goosefoot | rare | 24 |
| *Rhyncharrhena linearis* | Purple Pentatrope | vulnerable | 1 |
| *Sarcozona praecox* | Sarcozona | rare | 11 |
| *Sclerolaena patenticuspis* | Spear-fruit Copperburr | vulnerable | 2 |
| *Sida fibulifera* | Pin Sida | vulnerable | Incidental |
| *Sida intricata* | Twiggy Sida | vulnerable | > 5 |
| *Sida spodochroma* | Limestone Sida | vulnerable * | Incidental |
| *Tecticornia triandra*[5] | Desert Glasswort | rare | 1 |
| *Tragus australianus* | Small Burrgrass | vulnerable | > 20 |
| *Triraphis mollis* | Purple Needlegrass | rare | 6 |
| *Velleia arguta* | Grassland Velleia | rare | 3 |
| *Vittadinia eremaea* | Desert New Holland Daisy | New record | Incidental |

[1] Vulnerable defined as 'not presently endangered but likely to become so soon due to continued depletion; or occurring mainly on sites likely to experience changes in land-use which could threaten the survival of the species in the wild; or species whose total populations are so low that recovery from local disturbance could be unlikely'.
[2] Rare defined as 'rare in Victoria but not considered otherwise threatened. This category does not necessarily imply that the species is substantially threatened, but merely that there are relatively few known stands'
[3]Note: whilst this species is listed in the Victorian Census (2007) as rare, it is widespread and relatively common in north-western Victoria.
[4] Poorly Known defined as 'suspected, but not definitely known, to belong to categories rare, vulnerable or endangered'.
[5]formerly known as *Pachycornia triandra*.

but concentrated in non-mallee sites (i.e. non-eucalypt sites, which are only exceptionally burnt). In spite of its spiny nature, it appears to be relatively palatable. For many years the more common Spine Bush *Acacia nyssophylla* was confused with Wait-a-while. All records of Wait-a-while before the mid-1980s are suspect and should be checked; it is suspected that many may be re-determined as *A. nyssophylla*.

***Amyema linophylla* Buloke Mistletoe** (front cover)
DEPI list: vulnerable.
New Records: Fewer than five new records, all within former range.
Representative Locality: 534811 / 6194098
Implications: None; current status is supported. The plant is not widespread and is largely an obligate parasite on Buloke *Allocasuarina lue-*

*hmannii* and Belah *Casuarina pauper* in Victoria, although it is occasionally recorded on other hosts (Marriott 2012). Both Buloke and Belah are greatly reduced in abundance and heavily browsed (as is Buloke Mistletoe itself) wherever the foliage is accessible to kangaroos or domestic stock.

***Atriplex acutibractea* subsp. *acutibractea* Pointed Saltbush**
DEPI list: vulnerable and listed under the Flora and Fauna Guarantee Act 1988.
New Records: One new locality, with approximately five plants, a major outlier from its (former) known range in Victoria (Nowingi to Mildura).
Representative Locality: 508817 / 6203488
Specimens: Lodged with the ARI Herbarium and the National Herbarium of Victoria (MEL).
Implications: None; current status is supported. The plant is not widespread. This is the first (and only) one of the recent Victorian records from a park or similarly protected reserve. In Victoria the species is associated with Oil Mallee *Eucalyptus oleosa*, Narrow-leaf Mallee *E. leptophylla*, White Mallee *E. gracilis* and Grey Mallee *E. socialis*, usually on slightly saline soils.

***Convolvulus clementii* Desert Bindweed**
DEPI list: vulnerable.
New Records: Two new records, all within the former range.
Representative Locality: 511810 / 6184943
Specimens: Lodged with the ARI Herbarium and the National Herbarium of Victoria (MEL).
Implications: Review current status. This species may be less threatened than the current designation 'vulnerable' implies. This species is only recently recognised for Victoria (Johnson 2001) and is under-collected and previously overlooked. Its habitat seems to be tightly restricted to heavy soil flats in the far north-west of the state and it is uncommon to locally common. Its distribution in Victoria is poorly known, as it has only recently been distinguished from *C. erubescens*. In NSW, it is described as mostly found on flat areas, such as dune swales and claypans subject to seasonal inundation, in areas of open grassy woodland.

***Eremophila oppositifolia* Twin-leaf Emu-bush**
DEPI list: rare.
New Records: Six new records, all within the known range in Victoria.
Representative Locality: 556392 / 6177413
Implications: None; current status is supported. The plant is not widespread, but may be locally common (particularly in high quality semi-arid woodlands).

***Eremophila scoparia* Silvery Emu-bush**
DEPI list: rare.
New Records: One new locality, some distance from former records, which are concentrated in the far north-east of the Sunset Country, immediately west of Mildura.
Representative Locality: 586686 / 6171660
Implications: None; current status is supported. Silvery Emu-bush is not widespread. This record is a notable range extension and, unlike most other Victorian occurrences, in a secure reserve.

***Eriochlamys behrii* Woolly Mantle**
DEPI list: rare.
New Records: One new locality, within the former range.
Representative Locality: 556398 / 6128871
Implications: Review current status. Recent taxonomic revision (Walsh 2007) has segregated the more southern populations as a new species, *Eriochlamys squamata*. Nevertheless, *E. behrii* remains common in suitable habitat (the upper margins of saline boinkas and seasonal lakes).

***Jasminum didymum* subsp. *lineare* Desert Jasmine**
DEPI list: vulnerable.
New Records: Four new records, within former range.
Representative Locality: 539840 / 6191161
Specimens: Lodged with the ARI Herbarium
Implications: None; current status is supported. In Victoria, Desert Jasmine is largely (but not wholly) restricted to high quality semi-arid woodland stands, which are also rare in occurrence.

***Maireana georgei* Slit-wing Bluebush**
DEPI list: vulnerable.
New Records: Two new localities, each with probably <10 plants, all within the known range in Victoria.
Representative Locality: 499061 / 6195895
Implications: None; current status is supported. The plant is widespread and yet nowhere common. It appears to be restricted to heavier, more fertile sites, supporting either grassland or open woodland (the focus of former licensed grazing). It is one of the most palatable *Maireana* species (Cunningham *et al.* 1981) and populations may increase over time (assuming continuing grazing/browsing control).

***Maireana sedifolia* Pearl Bluebush** (Fig. 4)
DEPI list: rare.
New Records: One new locality, within its known range in Victoria.
Representative Locality: 512182 / 6190133
Implications: None; current status is supported. In Victoria, Pearl Bluebush is largely restricted to heavier soils that are relatively fertile (and were thus preferentially alienated and cleared) in the north-west. It may be locally dominant, in small patches. This long-lived perennial is moderately valuable as forage, particularly in dry times (Cunningham *et al.* 1981), but only rarely germinates and establishes from seed (Noble 1977; Crisp 1978; Tupper and Muller 1985). Populations may slowly increase over (extended) time, assuming continuing grazing/browsing control.

***Maireana triptera* Three-wing Bluebush**
DEPI list: rare.
New Records: Twelve new records, within known range.
Representative Locality: 508817 / 6203488
Specimens: Lodged with the ARI Herbarium.
Implications: None; current status is supported. This small shrub may be locally common (i.e. it usually occurs as small stands of relatively high density but small total area, < 1 ha). Stands are few enough that a Viclist status of 'rare' is reasonable. Moles *et al.* (2003) found seed viability almost halved after a year buried in the soil; a curious observation, in contrast with recorded recurrences in sites after a good rainy season, despite previous lack of records.

**Fig. 4.** Pearl Bluebush *Maireana sedifolia*, January 2006, western Murray-Sunset National Park.

***Marsdenia australis* Doubah**
DEPI list: vulnerable.
New Records: Two new records, all within former range.
Representative Locality: 539428 / 6191659
Specimens: Lodged with the ARI Herbarium.
Implications: None; current status is supported. In Victoria, Doubah is largely (but not wholly) restricted to high quality semi-arid woodland stands, most of which have been cleared for agriculture. Doubah is also vulnerable to being browsed. Doubah is scattered but widespread throughout Central Australia and subject to increasing attention as a bush food, for which purpose it is already being commercially cultivated (Olive 2011).

***Phyllanthus lacunellus* Sandhill Spurge**
DEPI list: rare.
New Records: Two new records, approximately 25 plants in each locality, in expected habitat (sandy rises within woodland) for Sandhill Spurge.
Representative Locality: 508263 / 6213718
Specimens: Lodged with the ARI Herbarium.
Implications: None; current status is supported. Germination trials from samples collected in Western Australia found germination only in 'Autumn' conditions (Graham *et al.* 2004). No individuals were found at the sites from where seeds were collected, suggesting a long-term soil seed store. Only three individuals germinated (Graham *et al.* 2004).

***Ptilotus sessilifolius* Crimson Tails**
DEPI list: poorly known.
New Records: One new locality, within known range in Victoria.
Representative Locality: 630231 / 6160159
Implications: Little; current status is supported. Crimson Tails is not well known in Victoria, although reported as common elsewhere (Cunningham *et al.* 1981). It is likely to have been overlooked previously and may have suffered from former browsing.

***Radyera farragei* Desert Rose Mallow**
DEPI list: vulnerable.
New Records: Two new records and approximately five plants.
Representative Locality: 512085 / 6184575
Specimens: Lodged with the ARI Herbarium and the National Herbarium of Victoria (MEL).
Implications: None; current status is supported. Desert Rose Mallow is rarely recorded, and usually only after extended summer rains (as occurred in 2011–2012; Browne 1986).

***Rhagodia ulicina* Spiny Goosefoot**
DEPI list: rare.
New Records: Twenty-four new localities, all within its known range in Victoria.
Representative Locality: 573762 / 6165291
Implications: Review current status. Spiny Goosefoot is not widespread, but may be locally common. It was formerly confused with forms of *Chenopodium desertorum* or *Rhagodia spinescens*, and thus there are relatively few records (and all of these are relatively recent).

***Rhyncharrhena linearis* Purple Pentatrope**
DEPI list: vulnerable.
New Records: One new record, approximately five plants (difficult to count 'plants' as this species suckers freely) in standard habitat (disturbed Belah Woodland).
Representative Locality: 506760 / 6177745
Specimens: Lodged with the ARI Herbarium.
Implications: None; current status is supported. Purple Pentatrope is palatable and vulnerable to being browsed.

***Sarcozona praecox* Sarcozona**
DEPI list: rare.
New Records: Eleven localities added, all within the known range in Victoria.
Representative Locality: 539428 / 6191659
Implications: Review current status. Sarcozona is widely scattered throughout the northern Mallee, but is rarely locally abundant. This species is often confused with *Carpobrotus* and *Disphyma* species, so it may be more common than the 300+ records imply.

***Sclerolaena patenticuspis* Spear-fruit Copperburr** (Fig. 5)
DEPI list: vulnerable.
New Records: Two new locality records, within known range.
Representative Locality: 512058 / 6193869
Specimens: Lodged with the ARI Herbarium and the National Herbarium of Victoria (MEL).
Implications: Review current status. Spear-fruit Copperburr is not widespread. It occurs in a few localised populations, but with substantial numbers of individuals. The plants are probably subject to heavy browsing in more typical seasons and Spear-fruit Copperburr was formerly considered threatened. As with other (mildly) palatable *Sclerolaena* species, it is likely to have benefitted from a couple of benign summer seasons (2010–11 and 2011–12) and a dramatic reduction in browsing pressure.

***Sida fibulifera* Pin Sida**
DEPI list: vulnerable.
New Records: More than five records, all within former range.
Representative Locality: 515157 / 6209843
Specimens: Lodged with the ARI Herbarium and the National Herbarium of Victoria (MEL).
Implications: Review current status. Pin Sida is not widespread in the state, but is widespread in the Millewa region (especially now that browsing pressure has been reduced). In this study it occurred in many (former) woodland quadrats and with substantial numbers of individuals. The plant is probably subject to heavy browsing

**Fig. 5.** Spear-fruit Copperburr *Sclerolaena patenticuspis*, January 2012, north-western Murray-Sunset National Park. Photo Kate Bennetts.

in more typical seasons and was formerly considered threatened. As with other palatable *Sida* species, it is likely to have benefitted from the recent benign summer seasons (2010–11 and 2011–12) and a dramatic reduction in browsing pressure. The seed, although of low viability (13% viable), maintained viability after a year in soil (10%, Moles *et al.* 2003). Pin Sida likely maintains a long-term viable seed store.

***Sida intricata* Twiggy Sida**
DEPI list: vulnerable.
New Records: More than five new records, all within former range.
Representative Locality: 514855 / 6191538
Specimens: Lodged with the ARI Herbarium.
Implications: Review current status. As with Pin Sida, Twiggy Sida is not widespread in the state, but is widespread in the Millewa region. In this study, it occurred in many (former) woodland quadrats and with substantial numbers of individuals. The plant is probably subject to heavy browsing in more typical seasons and was formerly considered threatened. As with other palatable *Sida* species, it is likely to have benefitted from the recent benign summer seasons (2010–11 and 2011–12) and a dramatic reduction in browsing pressure.

***Sida spodochroma* Limestone Sida**
DEPI list: vulnerable and listed under the *Flora and Fauna Guarantee Act 1988* (there is a current Action Statement, DSE 2003).
New Records: More than five records, all within former range.
Representative Locality: 509880 / 6215823
Specimens: Lodged with the ARI Herbarium.
Implications: Review current status and revise the Action Statement. Limestone Sida is not widespread in the state nor in the region, and is far less common than the above-listed *Sida* species. According to the Action Statement

(DSE 2003), only eight small populations had been found on limestone soils in the Red Cliffs-Cardross area, within 10.5 km of each other. In the Millewa area, Limestone Sida is largely restricted to areas where limestone approaches, or outcrops at, the surface. Limestone Sida occurred in a few (former) woodland quadrats and was occasionally locally common. The plant is probably subject to heavy browsing in more typical seasons and was formerly considered threatened.

***Tecticornia triandra* Desert Glasswort**
DEPI list: rare.
New Records: One new locality, somewhat removed from its (former) known range in Victoria (old river terraces west of Mildura and Rocket Lake).
Representative Locality: 575887 / 6166604
Implications: None; current status is supported. The plant is not widespread and has not been overlooked as it cannot reasonably be confused with any other species from the region.

***Tragus australianus* Small Burr-grass**
DEPI list: rare.
New Records: More than 20 new records, each with anything between 1 and 50 plants, all within former range.
Representative Locality: 506760 / 6177745
Specimens: Lodged with the ARI Herbarium.
Implications: Review current status, as its abundance in the current study suggests that this species should no longer be considered rare or otherwise threatened. This year (2012) it was widespread in the north-western Millewa area and in most of the 137 sites surveyed. The local population in January 2012 was estimated at >50 000 plants. Low germination rates and similar rates at temperatures from 12°C to 28°C suggest the possibility of year-round establishment. One study revealed a high speed of germination with 50% of the seeds germinating on the first day (Jurado *et al.* 1992), suggestive of a disturbance responsive life form. Small Burr-grass is widespread throughout the arid and semi-arid areas of mainland Australia. In Victoria, Small Burr-grass is seasonal in occurrence and its abundance in 2012 is probably attributable to extended summer rainfall, combined with effective control over rabbit and kangaroo populations. In less benign seasons it is likely to retreat to a soil seed store.

***Triraphis mollis* Needle Grass**
DEPI list: rare.
New Records: Six new localities, each with many individuals, all within the former known range in Victoria.
Representative Locality: 626751 / 6164520
Implications: None; current status is supported. The plant is not recorded in most seasons (Sandell 2003) and is (locally) common only after extended summer rains, as occurred in 2011 and 2012. It tolerates, or even benefits from, moderate soil disturbance (Cunningham *et al.* 1981).

***Velleia arguta* Grassland Velleia**
DEPI list: rare.
New Records: Three new localities, all within the known range in Victoria.
Representative Locality: 512085 / 6209220
Implications: None; current status is supported. In Victoria, Grassland Velleia is largely restricted to little-disturbed grasslands in the north.

***Vittadinia eremaea* Desert New Holland Daisy**
DEPI list: none; 'rare' status is recommended.
New Records: One new locality, with an unknown number of plants (suspected to be well over 50). Along with another record in the same season, from Ian Sluiter of Ogyris Consulting, this is the first specimen record for Victoria at the National Herbarium of Victoria (MEL).
Specimens: Lodged with the National Herbarium of Victoria (MEL).
Implications: Assessment and inclusion recommended. Desert New Holland Daisy is widespread and locally common throughout arid Australia, but this year's records are the first specimen records for Victoria at MEL. Desert New Holland Daisy is relatively unattractive as forage (Read 1999) and appears to have only a short-term soil seed store (Moles *et al.* 2003). As a result, it is likely that these recent records in Victoria are as much in response to two relatively benign summers (2010–11 and 2011–12) as to reduced browsing pressures. Nevertheless, it is among the more distinctive of the *Vittadinia* species and unlikely to have been consistently overlooked in the past.

## Discussion

There is always some inference and extrapolation in attributing causes to changes observed in the landscape. Data may help clarify and partially justify suggested causal connections but rarely provide absolute proof (i.e. with no uncertainty). Nevertheless, reasonable causal connections can still be determined as is the case with these new records of 28 rare and threatened species that inhabit semi-arid woodlands in the Victorian Mallee.

Formal protection of the large reserves in north-western Victoria was a consequence of the Land Conservation Council studies in the 1970s and 1980s (Land Conservation Council 1974, 1977, 1987). Domestic stock were not immediately removed from these reserves, but were gradually removed over the following 15 years or so. At the same time, control of introduced herbivores (notably rabbits) was introduced as a concerted planned campaign (Sandell 2006). Control measures were also extended to other herbivores, including kangaroos, as it became apparent that there could be scant woodland regeneration under continuing high grazing/browsing pressures (Sandell *et al.* 2002; Callister 2004; Parsons 2006; Cheal 2009a, b; Gowans *et al.* 2010). Currently, grazer/browser populations throughout much of the Mallee parks and reserves are maintained at significantly lower levels than at any time since park declaration.

Most of the rare and threatened plants discussed here are variously palatable to mammalian browsers/grazers (Cunningham *et al.* 1981; Sandell *et al.* 2002; Sinclair 2005). 'Palatability' is not an absolute characteristic. The likelihood of a plant being harvested by a herbivore depends on the amount of alternative forage (and thus indirectly on seasonal conditions). Nevertheless, in times of shortage, unpalatable plants may be edible (Beetham *et al.* 1987; Sandell 2003). Shortage of forage may be due to adverse seasonal conditions (such as droughts) or abundant competitors for the available forage, or some combination of these.

At least seven of the 28 rare or threatened species identified from the current study (Table 1) are probably most reasonably interpreted simply as further records of long-lived perennial species from within their known ranges (i.e. *Acacia colletioides, Amyema linophylla, Eremophila scoparia, Jasminum didymum, Maireana sedifolia, Sarcozona praecox* and *Tecticornia triandra*). Others may be misinterpretations of known distributional data (i.e. *Eriochlamys behrii, Ptilotus sessilifolius* and *Rhagodia ulicina*). However, most (all?) of the remainder can reasonably be interpreted as recovery (higher populations or wider distributions) following two benign seasons and extensive control of grazers/browsers. For some of these, population increases and extensive re-establishment are a dramatic change from former restricted ranges with few individuals (e.g. *Atriplex acutibractea*, the three *Sida* species, *Tragus australianus* and *Triraphis mollis*). Recovery of these rare plants in previous benign seasons was not recorded in previous studies (Parsons and Browne 1982; Cheal *et al.* 1992; Parsons 2006), but is clearly indicated for most of the species in the current study.

It appears that (partial) recovery of the suite of rare plants discussed in the current study can be attributable to two principal factors:

- two benign summers, with rainfall extending into the summers, and
- over two decades of herbivore control, culminating in historically low populations of rabbits and other herbivores throughout much of the study area.

Each of these factors, on its own, is insufficient to enable recovery of rare plants. But when benign summers coincide with effective herbivore control, dramatic recovery in rare herbs and sub-shrubs can be expected, and has been observed in early 2012. Management in semi-arid communities necessitates a long-term perspective and a sensitivity to adverse contexts before the resultant degradation becomes overwhelming and essentially irreversible.

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## References


Australian Bureau of Meteorology (2012) Climate Data online. www.bom.gov.au/climate/data

Batty AL and Parsons RF (1992) Regeneration of *Acacia melvillei* in part of semi-arid South-eastern Australia. *Proceedings of the Royal Society of Victoria* **104**, 89–97.

Beetham P, Kiely J, Mackenzie J, Varrtjes S, Pennell AL and O'Brien TP (1987) Diet analysis of the Western Grey Kangaroo (*Macropus fuliginosus*) in Wyperfeld National Park by microscopic faecal analysis. *The Victorian Naturalist* **104**(2), 32–38.

Browne JH (1986) Members of the Malvaceae family rare in north western Victoria. *The Victorian Naturalist* **103**(5), 150–157.

Callister KE (2004) *Casuarina pauper (Belah) woodlands of northwest Victoria: monitoring and regeneration.* (Centre for Environmental Management, University of Ballarat: Ballarat)

Castle LJ (1989) *The regeneration status of Allocasuarina luehmannii (R. T. Baker) L. Johnson (Buloke) at Wyperfeld National Park.* (Botany and Zoology, Monash University: Clayton, Vic)

Cheal D (2009a) Recovery in the Mallee. *Parkwatch.* **239**, 24–25.

Cheal DC (2009b) Twenty years of grazing reduction in semi-arid woodlands. *Pacific Conservation Biology* **15**(4), 268–277.

Cheal D, Lucas A and Macaulay L (2012). *National Recovery Plan for Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions.* (Department of Sustainability, Environment, Water, Population and Communities: Canberra)

Cheal DC, Parkes D, Parsons RF and Sluiter IRK (1992). *Vascular Plants and Communities.* (Australian National Parks and Wildlife Service and the Murray Darling Basin Commission: Canberra)

Cheal D, Westbrooke M, Gowans S and Gibson M (2007). *Vegetation change in Victorian Mallee Parks.* (Arthur Rylah Institute for Environmental Research: Heidelberg, Victoria and University of Ballarat: Ballarat)

Cohn JS and Bradstock RA (2000) Factors affecting post-fire seedling establishment of selected mallee understorey species. *Australian Journal of Botany* **48**(1), 59-70.

Connor DJ (1966) Vegetation studies in north-west Victoria I. The Beulah-Hopetoun area. *Proceedings of the Royal Society of Victoria* **79**, 579–597.

Crisp MD (1978) Demography and survival under grazing of three Australian semi-desert shrubs. *Oikos* **30**, 520-528.

Cunningham GM, Mulham WE, Milthorpe PL and Leigh JH (1981) *Plants of Western New South Wales.* (NSW Government Printing Office: Sydney)

Department of Sustainability and Environment (2003) Action Statement. Flora and Fauna Guarantee act 1988. No. 152 Limestone Sida, *Sida spodochroma.* (Department of Sustainability and Environment: East Melbourne)

Department of Sustainability and Environment (2005) *Advisory list of rare or threatened plants in Victoria - 2005.* (Department of Sustainability and Environment: East Melbourne)

Gowans S and Westbrooke M (2002). Hattah-Kulkyne National Park vegetation condition assessment. Ballarat, Victoria. (Centre for Environmental Management, University of Ballarat; Ballarat)

Gowans SA, Callister KE, Westbrooke ME and Gibson MS (2005) Vegetation condition assessment of the semi-arid woodlands of Murray-Sunset National Park, Victoria. *The Victorian Naturalist* 122(2), 85–93.

Gowans SA, Gibson MS, Westbrooke ME and Pegler P (2010) Changes in vegetation condition following kangaroo population management in Wyperfeld National Park. In *Macropods: the biology of Kangaroos, Wallabies and Rat-kangaroos,* pp. 361-370. Eds G Coulson and M Eldridge. (CSIRO Publishing: Melbourne)

Graham RA, Florentine SK, Fox JED and Luong TM (2004) The germinable soil seedbank of *Eucalyptus victrix* grassy woodlands at Roy Hill Station, Pilbara District, Western Australia. *Rangeland Journal* **26**(1), 17–33.

Johnson RW (2001) A taxonomic revision of *Convolvulus* L. (Convolvulaceae) in Australia. *Austrobaileya* **6**(1), 1-39.

Jurado E and Westoby M (1992). Germination biology of selected central Australian plants. *Australian Journal of Ecology* **17**, 341–348.

Kenny S, Moxham C and Cheal D (2012) *Mapping of the condition of semi-arid non-eucalypt woodlands of high priority National Parks and Reserves* (Mallee Catchment Management Authority: Mildura)

Land Conservation Council (1974) *Report on the Mallee Study Area.* (Land Conservation Council of Victoria: Melbourne)

Land Conservation Council (1977) *Final Recommendations Mallee Study Area.* (Land Conservation Council of Victoria: Melbourne)

Land Conservation Council (1987) *Report on the Mallee Area Review.* (Land Conservation Council of Victoria: Melbourne)

Marriott N (2012) Our Mistletoes — their beauty and their value. *Growing Australian* **56.2**, 14–17.

Moles AT, Warton DI and Westoby M (2003) Seed size and survival in the soil in arid Australia. *Austral Ecology* **28**, 575–585.

Morcom L (2000) *The floristic composition and regeneration characteristics of Buloke* (Allocasuarina luehmannii) *woodland of the Wimmera, Victoria.* (Centre for Environmental Management: Ballarat)

Noble IR (1977) Long-term biomass dynamics in an arid chenopod shrub community at Koonamore, South Australia. *Australian Journal of Botany* **25**, 639–653.

Olive M (2011) *Mark Olive's Outback Cafe.* (R. M. Williams Publishing: Milsons Point, NSW)

Ooi MKJ, Auld TD and Denham AJ (2009) Climate change and bet-hedging: interactions between increased soil temperatures and seed bank persistence. *Global Change Biology* **15**, 2375-2386.

Parsons RF (2006) Threatened vascular plants of north-west Victoria. *Proceedings of the Royal Society of Victoria* **118**(2), 333-340.

Parsons RF and Browne JH (1982) Causes of plant species rarity in semi-arid southern Australia. *Biological Conservation* **24**, 183–192.

Raymond KL (1990) *The regeneration biology of* Allocasuarina luehmannii *(R. T. Baker) L. Johnson at Wyperfeld National Park.* (Ecology and Evolutionary Biology, Monash University: Clayton)

Read JL (1999) The initial response of a chenopod shrubland plant and invertebrate community to two pulses of intensive cattle grazing. *Rangeland Journal* 21(2), 169-193.

Sandell PR (2002) Implications of rabbit haemorrhagic disease for the short-term recovery of semi-arid woodland communities in north-west Victoria. *Wildlife Research* **29**, 591–598.

Sandell P (2003) *The implications of RHDV for biodiversity in north-west Victoria: Hattah RHD project.* (Parks Victoria and the Department of Sustainability and Environment: Mildura)

Sandell P (2006) Promoting woodland recovery in the Victorian Mallee Parks. *Proceedings of the Royal Society of Victoria* **118**(2), 313-321.

Sandell P, Ballentine M and Horner G (2002). *Vegetation recovery in the Victorian Mallee Parks 1991-1998.* (Parks Victoria: Melbourne).

Sinclair R (2005) Long-term changes in vegetation, gradual and episodic, on the TGB Osborn Vegetation Reserve, Koonamore, South Australia (1926-2002). *Australian Journal of Botany* **53**(4), 283–296.

Sluiter IRK, Minchin PR and Jaensch SC (1997) *The Buloke and Pine woodlands of semi-arid and dry sub-humid Victoria and nearby areas.* (Ogyris Ecological Research: Birdwoodton)

Tupper GJ and Muller WJ (1985) Preliminary observations on the effect of removal of Black Bluebush (*Maireana pyramidata*) and Pearl Bluebush (*M. sedifolia*) on shrub regeneration, herbage production and erosion potential. *Australian Rangeland Journal* 7(2), 103–106.

Walsh NG (2007) A revision of *Eriochlamys* (Asteraceae, Gnaphalieae). *Muelleria* **25,** 101–114.

Walsh NG and Stajsic V (2007). *A census of the vascular plants of Victoria,* 8 edn. (Royal Botanic Gardens of Victoria: Melbourne)

Westbrooke ME (1998) *The ecology and regeneration status of Belah woodlands in south-eastern Australia.* (Department of Botany, La Trobe University, Bundoora).

White M, Oates A, Brown J, Barlow T, McMahon A, Rosengren N, Cheal D, Sutter G, Sinclair S, Chesterfield E, Frood D and Pelikan M (2003) *Vegetation mapping north-west Victoria.* (Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment; East Melbourne)

Williams RJ, Raymond KL, Lee LJ, O'Brien TP and Newnham R (2004a) *Regeneration status of Allocasuarina luehmannii woodlands at Wyperfeld, in semi-arid southeastern Australia: seed germination and seedling establishment.* (Monash University, Clayton, Vic).

Williams RJ, Raymond KL, Lee LJ, O'Brien TP and Newnham R (2004b) *Regeneration status of Allocasuarina luehmannii woodlands at Wyperfeld, in semi-arid southeastern Australia: seed production, seed harvesting and the soil seed bank.* (Monash University, Clayton, Vic).

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## One Hundred Years Ago

A PLEA FOR THE MURRAY PINE.—Some years ago, when visiting the Riverina district in the vicinity of Moulamein, in company with Mr. A. J. Campbell, I was grieved to see the rapid disappearance of the Murray Pine, *Callitris robusta,* var. *verrucosa,* before the axe of the settler. This tree yields perhaps the most useful of Australian timbers in the interior, being white ant proof, but, unfortunately, is generally of small size, rarely exceeding 15 to 18 inches in diameter at the base, and as the trunk tapers rapidly, it consequently takes a large number of trees to furnish sufficient timber for a moderate-sized building. At a saw-mill which we visited the waste was very great. Seldom did a log produce many boards six inches wide from fourteen to sixteen feet long. These were sold at from 12s. 6d. to 14s. 6d. per hundred feet running. Mr. Williamson, in his paper on the botany of Mildura, speaks of this pine furnishing the stakes required in the vineyards, and, as the smaller trees are used for fencing posts, the demand must soon exceed the supply. Another use to which this pine was put some three or four years after our visit was to furnish food for the settlers' sheep during a severe drought. For this purpose the friends with whom we stayed used no less than 1,700 trees, the sheep being particularly fond of the foliage. These trees, it may be mentioned, were all cut by the two girls of the family, their brother being ill in bed at the time. Notwithstanding the demand for this timber, we hear of no steps being taken to replant to meet the demand for future supplies. I have written these notes in no spirit of fault-finding, for I fully recognize the many and various uses to which the timber can be put, but to me it is lamentable that for so many years no effort has been made to provide for the future. Here is an opportunity for the Forest League to do practical work in calling attention to the immediate necessity for placing the Murray Pine timber trade under some sort of control. It seems strange that all remedies for good have to be forced physic-like on those most interested. Our own Club also, composed as it is of lovers of nature, should assist in bringing into prominence the rapid disappearance of this pine on the Victorian side of the Murray, and the urgent necessity for some steps being taken to prevent its ultimate extinction. Those who have seen a pine ridge will not readily forget the peculiar charm of the sight. We had the opportunity of visiting an untouched one in springtime, when the grass was beautifully green: the trees, dotted about as in a park, yielded delightful shadow effects in the afternoon sun, and, the base of the ridge being fringed with Bursaria and other bushes, the whole made a perfect picture of loveliness.—JOS. GABRIEL.

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